PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.	:	09/611,037
Applicant:	:	Kuthi, et al.
Filed:	:	July 6, 2000
Title:	:	METHOD FOR IMPLEMENTING A SEMICONDUCTOR PROCESS CHAMBER ELECTRODE
TC/A.U.	:	1763
Examiner	:	Alejandro Mulero, L.
Atty. Docket No.	:	LAM1P077A

Declaration Under 37 CFR §1.132

I, Lumin Li, declare as follows:

1. I am a named inventor in the subject application. I earned an undergraduate degree in Electronic Engineering from Southeast University, and Ph.D. degree in Electrical Engineering from Colorado State University. I currently work in reactor design and process applications of plasma etcher, and have been employed for 11 years. For the past 8 years, I have been with Lam Research Corporation working on new dielectric etcher development.

2. I have reviewed the patent to Tomita et al. (U.S. Patent No. 5,593,540), the reference patent. The reference patent teaches how to prevent polymer deposition in the small holes of a showerhead electrode by high speed of gas flow. To achieve a mass flow speed of at least 620 $kg/m^2/hr$, the reference specifies the diameter of the holes in the showerhead must be smaller than 0.6 mm. The reference specifies 0.6 mm as the maximum diameter of the hole. Any hole larger than 0.6 mm will reduce gas speed and cannot prevent polymer deposition.

3. Our claimed invention described in the subject application is in the field of plasma physics. Our claimed invention teaches how to reduce sheath voltage next to the top electrode. By forming the plasma sheath inside the holes, the surface area of the plasma sheath next to the top electrode is increased, and its potential is reduced. The holes in the claimed invention must big enough to allow plasma to exist inside to form a hollow cathode discharge.

4. The diameter of the holes on the electrode showerhead is very critical for showerhead design. Increasing gas flow speed, and increasing the surface area of a plasma sheath are in different fields and have different technological focus. A large diameter of hole will reduce backside pressure, and will reduce gas flow speed through the holes. As a result, polymer may deposit inside holes. The reference patent specifies the maximum diameter of hole. Any hole larger than 0.6 mm will reduce gas speed and cannot prevent polymer deposition. On the contrary, hole size in our claimed invention must be bigger than a thickness of the plasma sheath to allow the sheath to form inside the hole. We specified the minimum hole size of 0.5 mm. The diameter of any hole larger than 0.5 mm will meet the requirement for a hole size, depending on various process parameters, including plasma sheath thickness.

5. Plasma sheath thickness depends on pressure, power and chemistry. For different etch applications, pressure in our etcher could vary from 10 mT to 2T, power could be 50W to 6KW, and there are more than 16 available gases. In order to include a wide range of plasma etch process regimes, we chose a diameter of 0.5 mm conservatively as the minimum size for the worst case with a high pressure, low power, and heavy polymer contents. For most of our applications, we prefer diameter of showerhead holes to be 2 ~ 10 mm.

6. Diameter of showerhead holes must be very small not only for gas flow speed, but also for preventing plasma light-up inside the hole. It is well known that when the hole is too large, and at high pressure, according to Paschen curve, plasma will ignite inside the hole. When plasma exists inside the hole, dense plasma inside of the hole will dissociate more species and generate more polymers inside the holes. As a result, there is or will be more polymer deposition. When plasma lights-up inside a hole, a sheath with high potential will accelerate ions and sputter away the electrode material. Plasma ignited inside a hole of showerhead is not desirable for a plasma etcher. The fast erosion of the electrode will quickly affect process repeatability, increase polymer deposition, and reduce lifetime of showerhead. It is a basic rule in plasma etcher design that the showerhead should prevent plasma light-up inside the hole. Our claimed invention purposely increases hole size and forms plasma in a portion of the hole, and is a

special case in which an increase in ion's energy on the wafer is critical for certain etch applications.

7. In our claimed invention, there are two different diameters of each hole specified for electrode showerhead design. The diameter of the hole in the top end and close to gas source (the gas feed holes) is 0.1 mm which is designed to prevent plasma from entering the holes and light-up inside of the holes and on a backside of the shower head. The diameter of the holes in the lower end and in contact with plasma (the electrode openings) is 0.5 mm which is designed to create plasma inside hole, increase the surface area of the plasma sheath next to the top electrode and increase the potential at the opposite electrode.

8. The objective of the reference patent is preventing polymer deposition. The size of the holes in the showerhead must be small enough to obtain the certain disclosed flow speed. At the same time, the flow speed must be maintained to prevent plasma light up inside the holes. A diameter of 0.6mm does not inherently shift the plasma sheath into the openings and create a surface area next to the electrode that is larger than the surface area that is next to the wafer. It is against common sense, basic plasma physics, and design rules for those skilled in the art -- that is, one of average competence and expertise in the field of plasma etch, would not modify the reference in such a manner as to increase size of the holes and purposely create plasma inside holes.

9. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 USC §1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

LUMIN LI

9-3-03
DATE